Regional Vulnerability Assessment: Definition, History, Application, and Future

Betsy Smith, Ph.D.
Regional Vulnerability Assessment (ReVA) Program
EPA, Office of Research and Development
National Exposure Research Laboratory
www.epa.gov/reva

Problem

Given multiple stresses affecting multiple endpoints simultaneously, how can limited resources be targeted to maximize benefits and minimize problems?

How do we incorporate various perspectives to balance among competing priorities?

Clients

EPA Regional Offices

EPA Program Offices

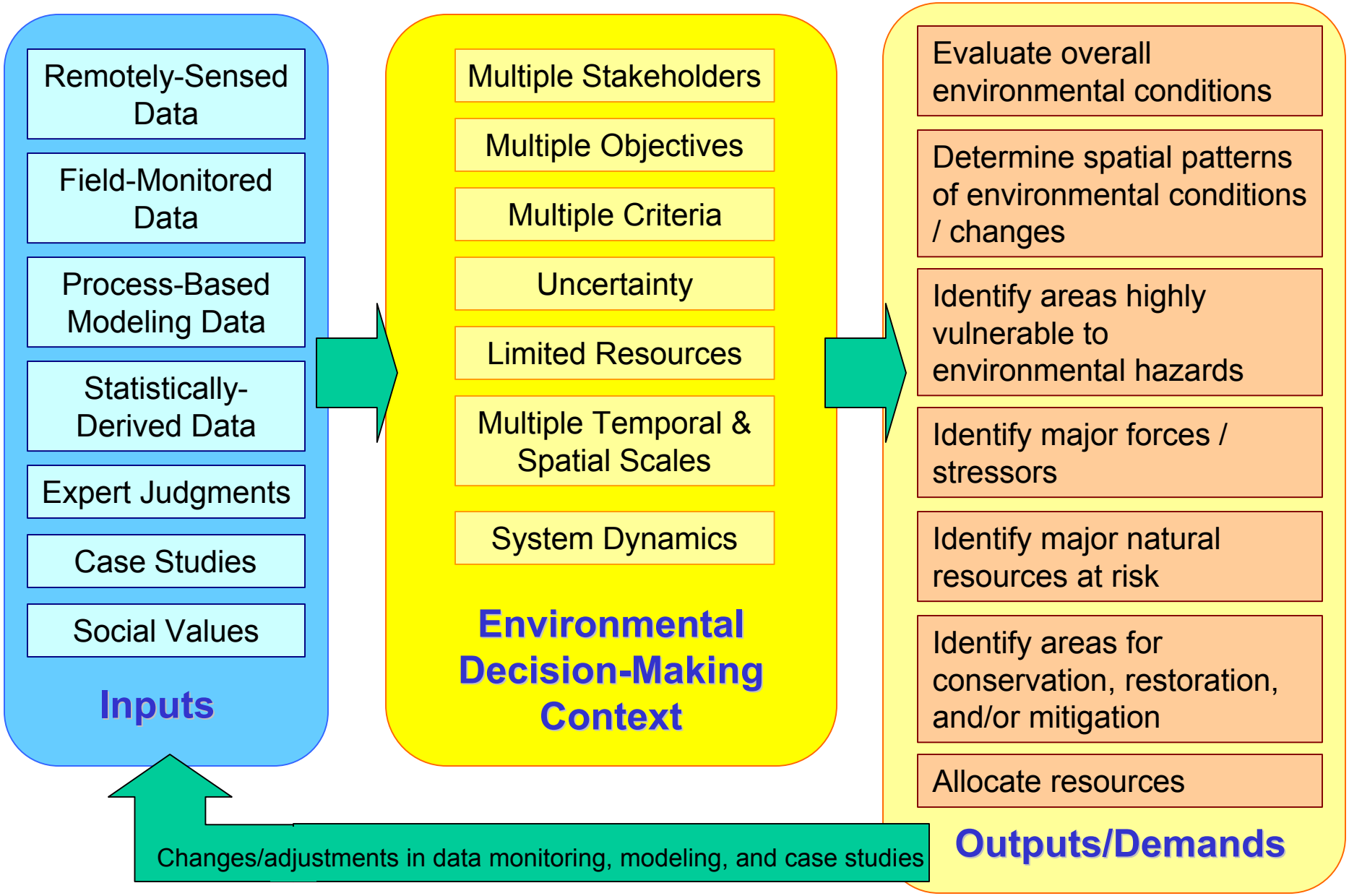
Other Federal Agencies

NGOs

State and Local Decision-makers

....Anyone faced with this and no tools at hand to do it well...

Regional Environmental Decision-Making



ReVA: the Research Program

Supporting Research on:

New Indicators
New Spatial Models
Integration Methods
Socio-Economics
Decision Tools
Quantifying Error and Uncertainty
Issues of Scale
Information Technology

ReVA's Environmental Decision Toolkit (EDT)

Making Research Results Accessible:

Web-based, integration and visualization
Data diagnostics and data preparation
Integration of data in subgroups
Weighting in support of multi-criteria decision making
Data access

ReVA: the Approach

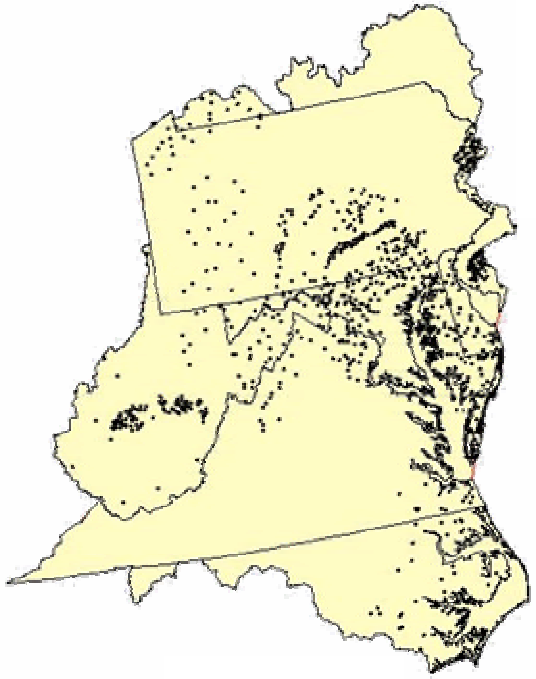
ReVA's Integrated Assessment Framework Helps Organize Research Knowledge and Tools to Respond to Client Needs

- **Data acquisition / preparation**
- **Extrapolation / interpolation**
- **Model development / forecasting**
- **Synthesis**
- **Scenario Analysis**
- **Visualization/Communication/Access to Information**

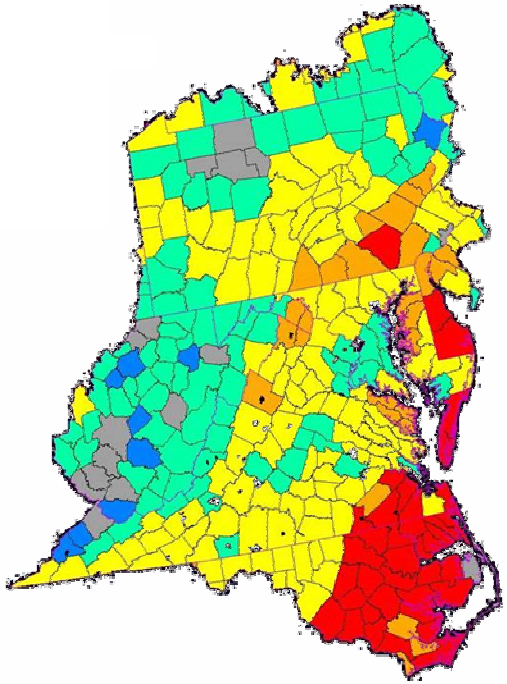
EDT

EDT = ReVA's web-based Environmental Decision Toolkit

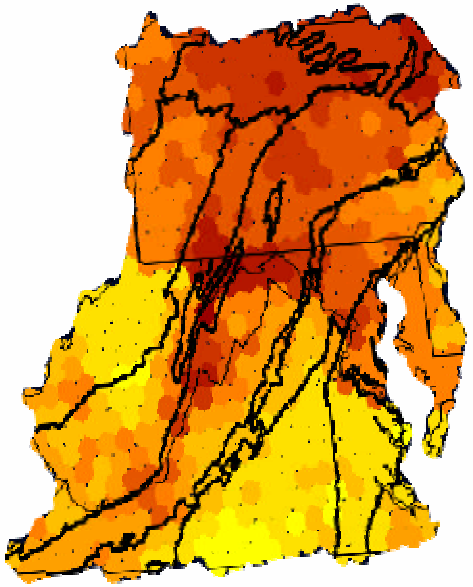
Spatial Data
Point and Polygon



NAWQA Sample Sites

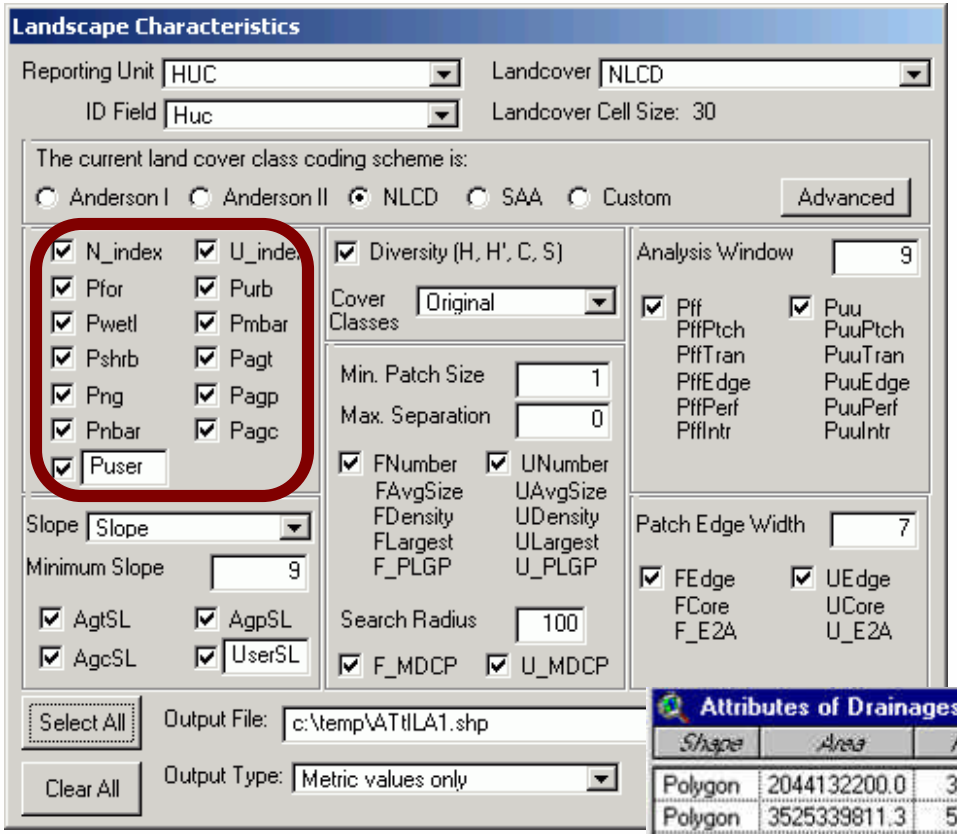


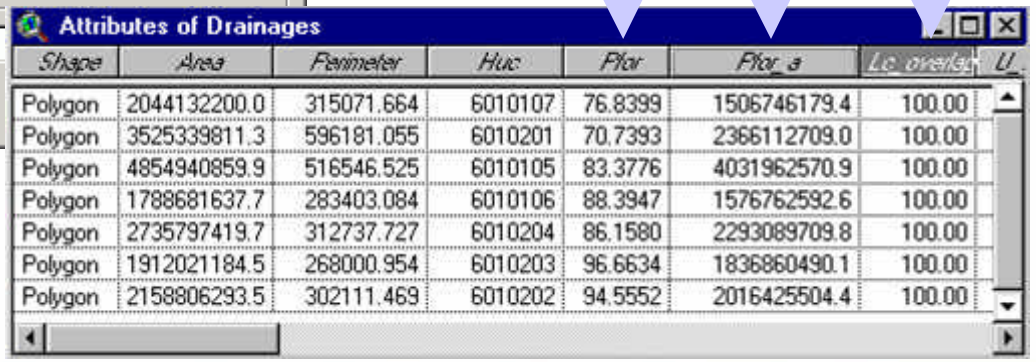
Insecticide (lbs/acre)



Native Species (counts)

Analytical Tools Interface for Landscape Assessment - ATtILA



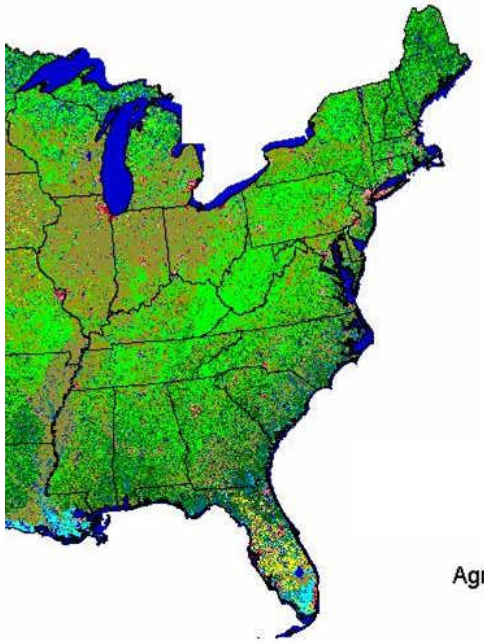


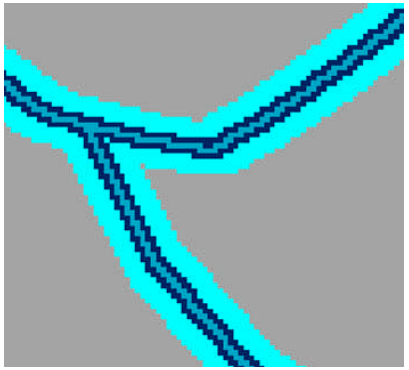
Shape	Area	Perimeter	Huc	Pfor	Pfor_a	Le_overlap	U_
Polygon	2044132200.0	315071.664	6010107	76.8399	1506746179.4	100.00	
Polygon	3525339811.3	596181.055	6010201	70.7393	2366112709.0	100.00	
Polygon	4854940859.9	516546.525	6010105	83.3776	4031962570.9	100.00	
Polygon	1788681637.7	283403.084	6010106	88.3947	1576762592.6	100.00	
Polygon	2735797419.7	312737.727	6010204	86.1580	2293089709.8	100.00	
Polygon	1912021184.5	268000.954	6010203	96.6634	1836860490.1	100.00	
Polygon	2158806293.5	302111.469	6010202	94.5552	2016425504.4	100.00	

Single Variable Landscape Metrics

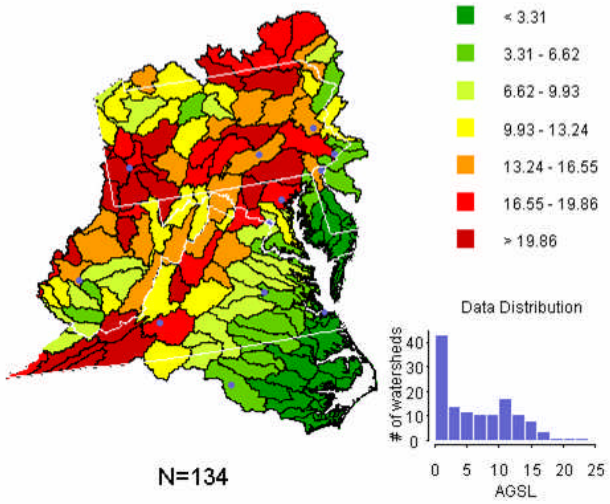
- Percentage of crop land
- Percentage of pasture
- Percentage of all Ag use
- Percentage of barren
- Percentage of forest
- Percentage of urban
- Percentage of wetland

ATtILA Multi-variable landscape metrics



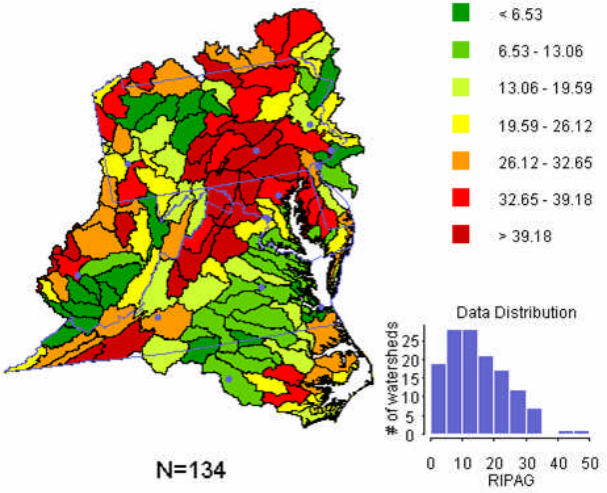


Agriculture land on steep slopes (%)



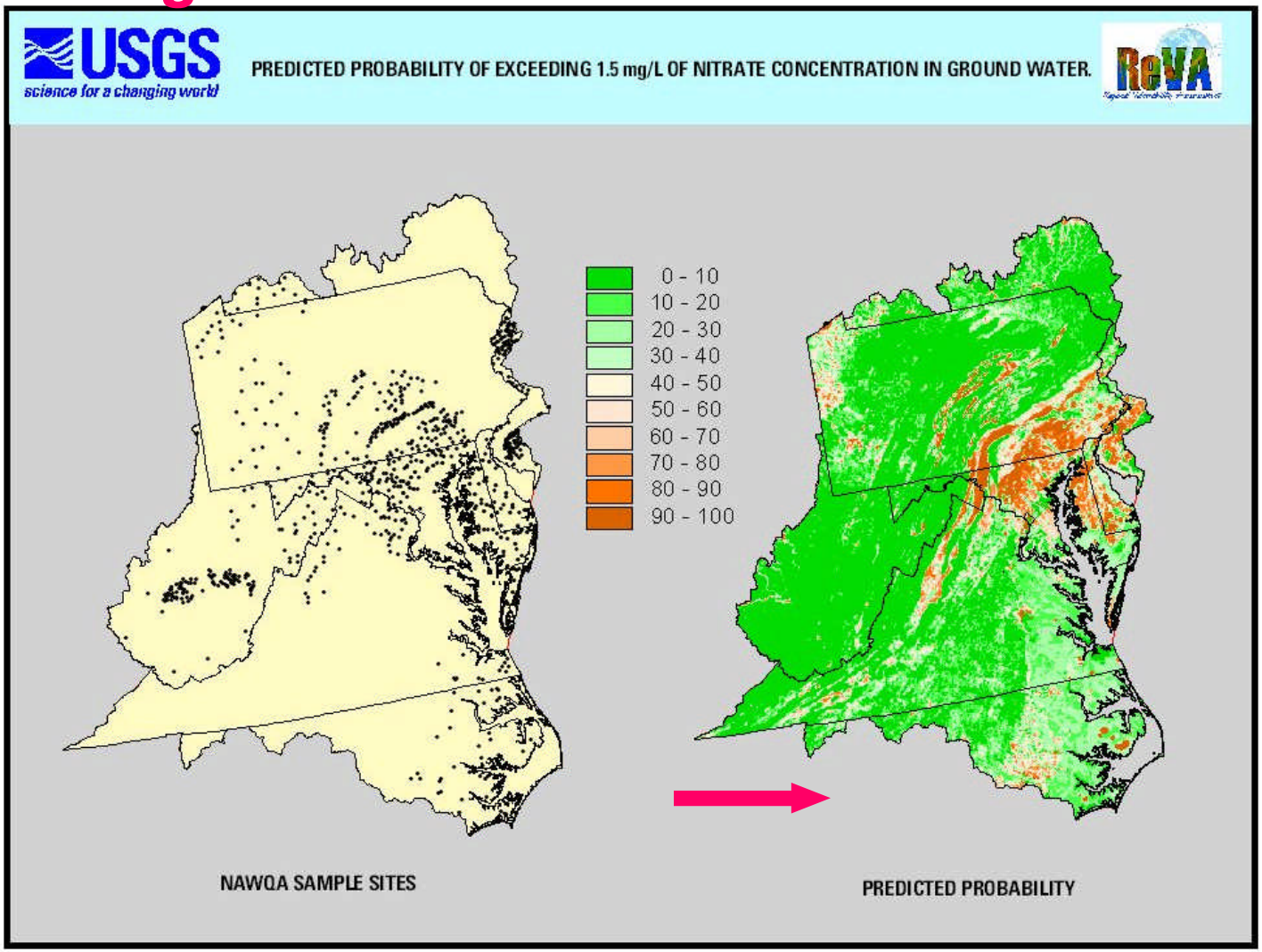
N=134

Agriculture land cover along streams (%)

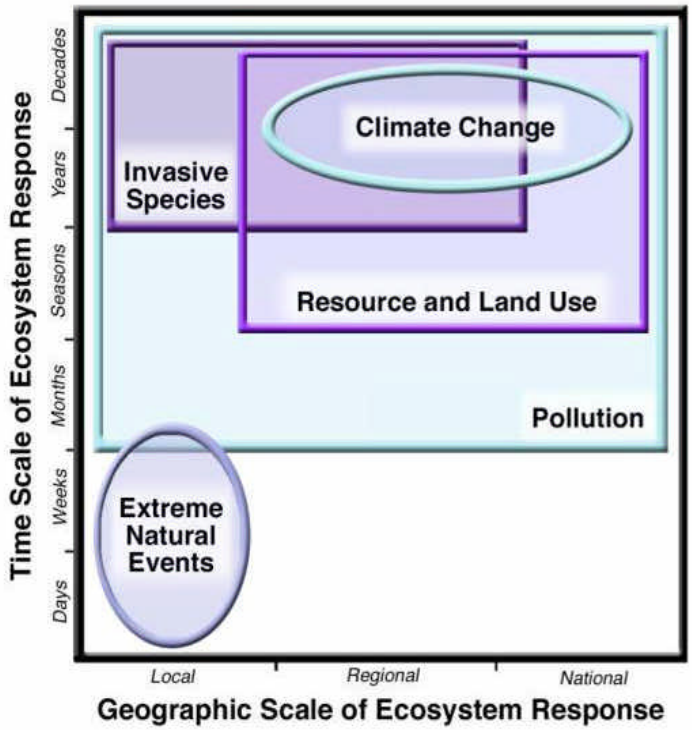


N=134

ReVA is estimating condition across the map using *existing* data



Future Scenarios: Projections of Major Drivers of Ecological Change (2020)



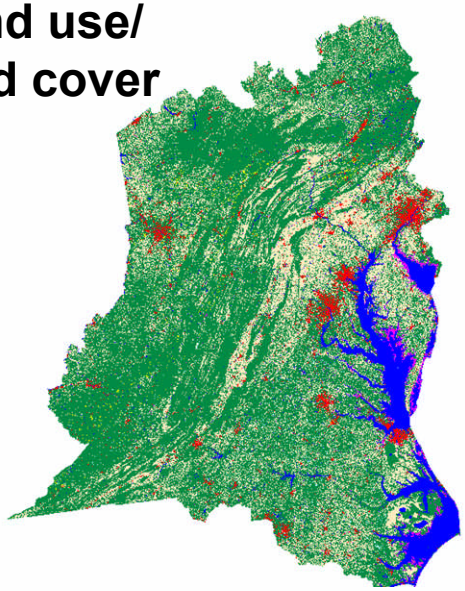
Despite compliance with environmental regulations, biological populations are declining.

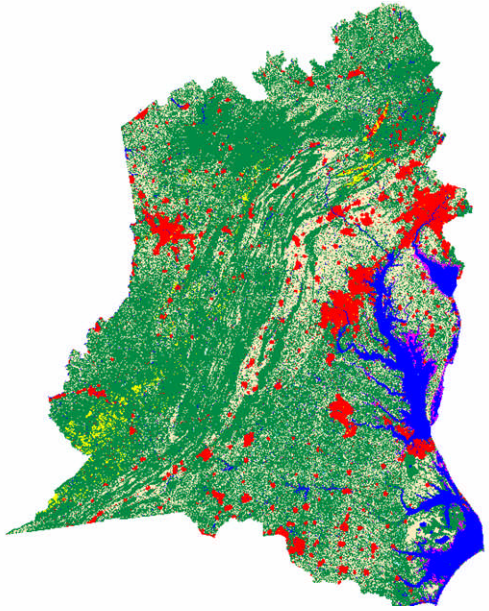
Major drivers of change include:

- **Land use change**
- **Resource extractions**
- **Pollution and pollutants**
- **Exotic invasive species**
- **Climate change**

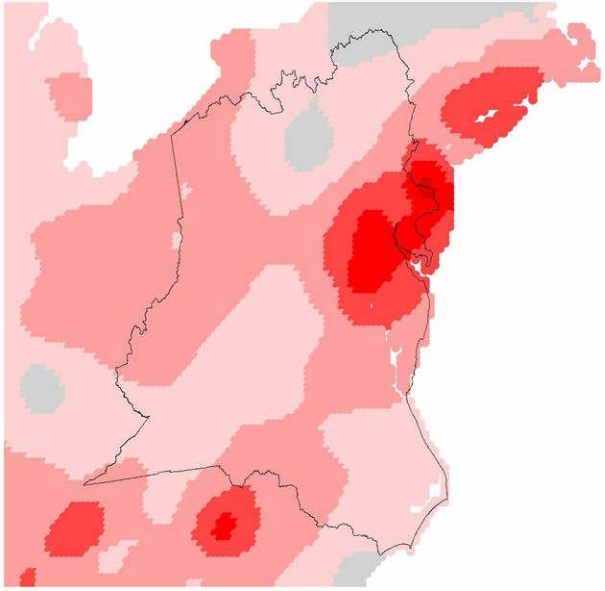
These drivers projected for the Mid-Atlantic Region

Land use/ land cover

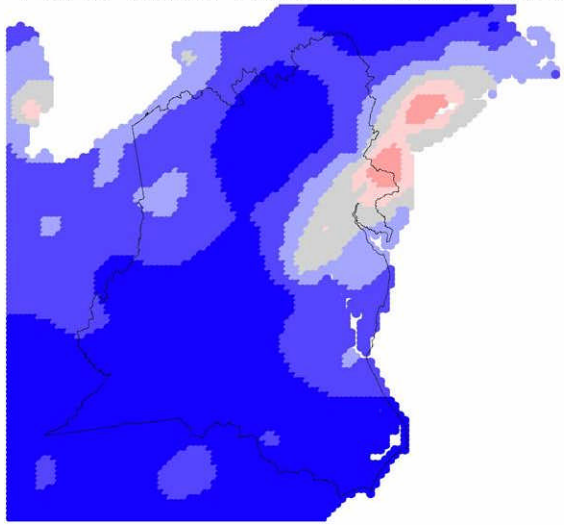




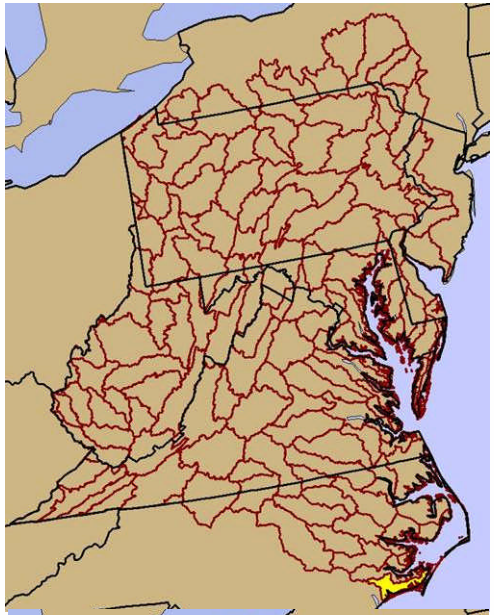
2001 Clear Skies Ozone Design Value

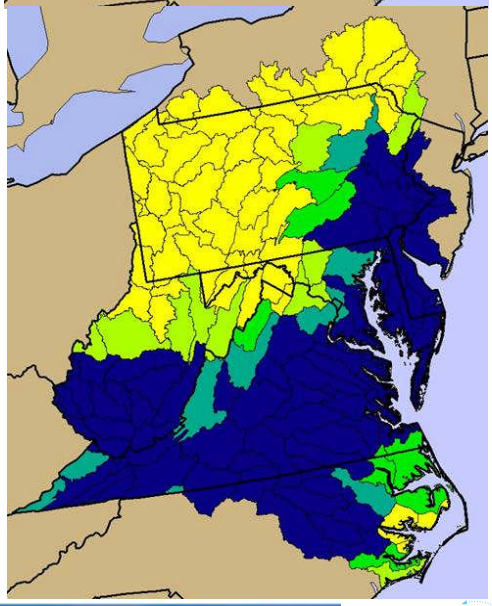


2020 Clear Skies Ozone Design Value

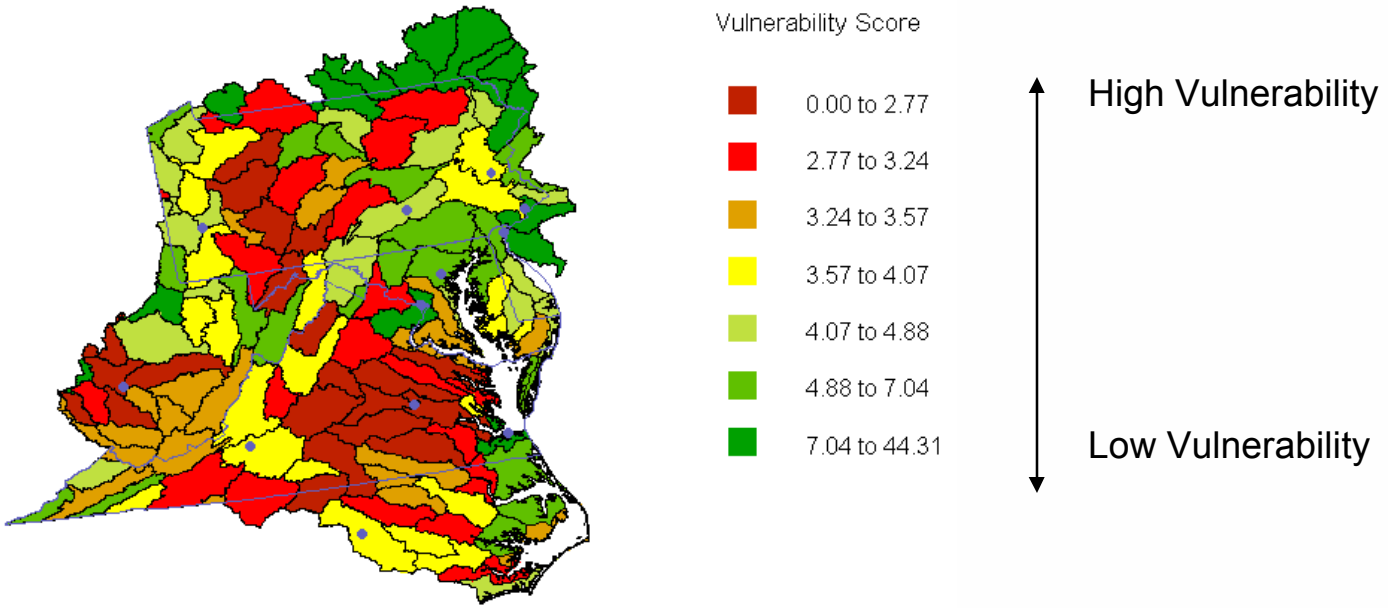


Giant Salvinia





ReVA synthesizes environmental data and model results to inform decision-making

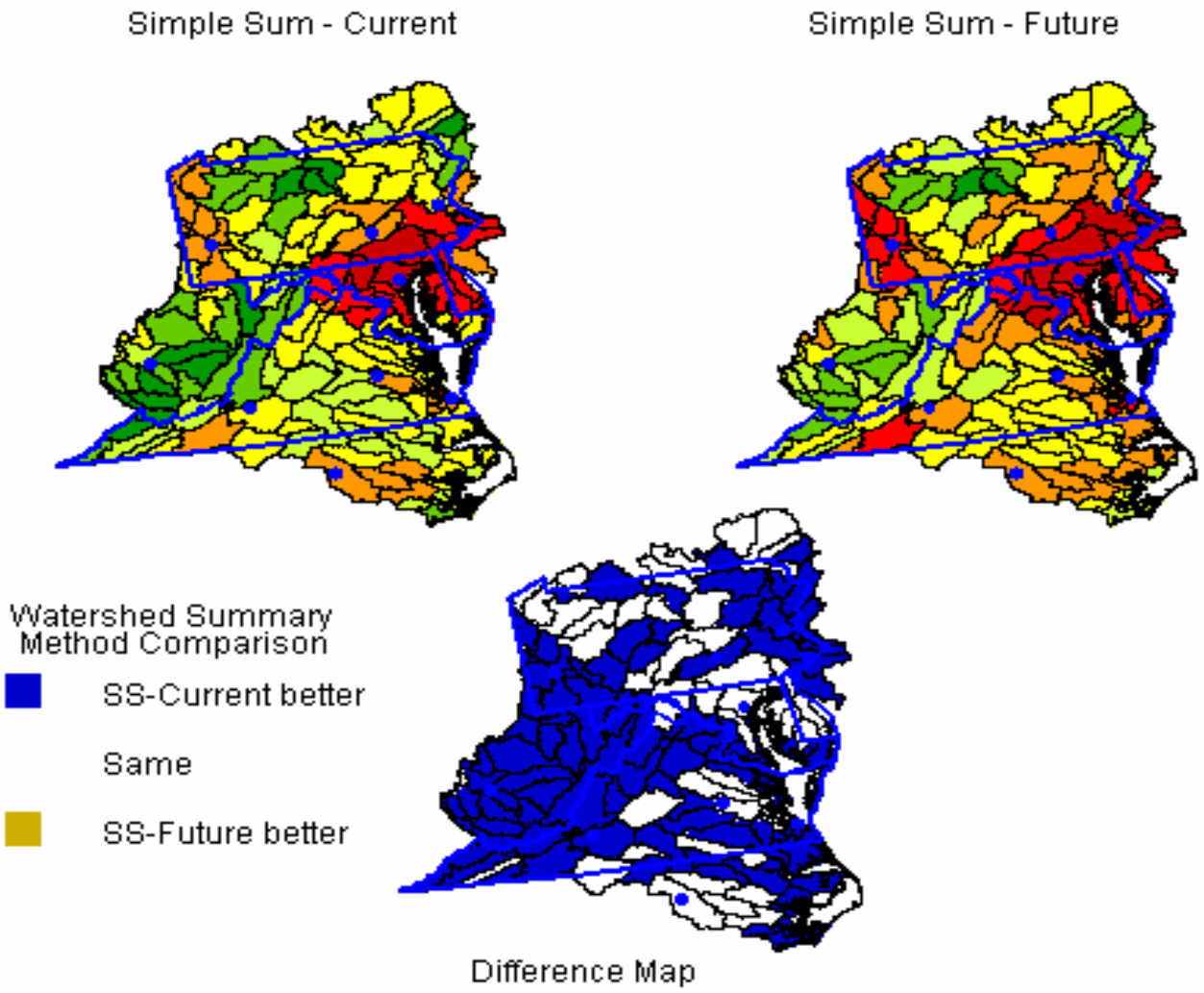


Why Integrate?

1) **To "boil down" huge amounts of data for decision-makers**

2) **When projecting future conditions, some things improve, some worsen, need to know net effect**

Mid-Atlantic Vulnerability Assessment: Changes in Overall Condition, 2020



EPA Regional Vulnerability Assessment (ReVA) Environmental Decision Toolkit - Microsoft Internet Explorer

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- Partners
- Site Map

ReVA Environmental Decision Toolkit

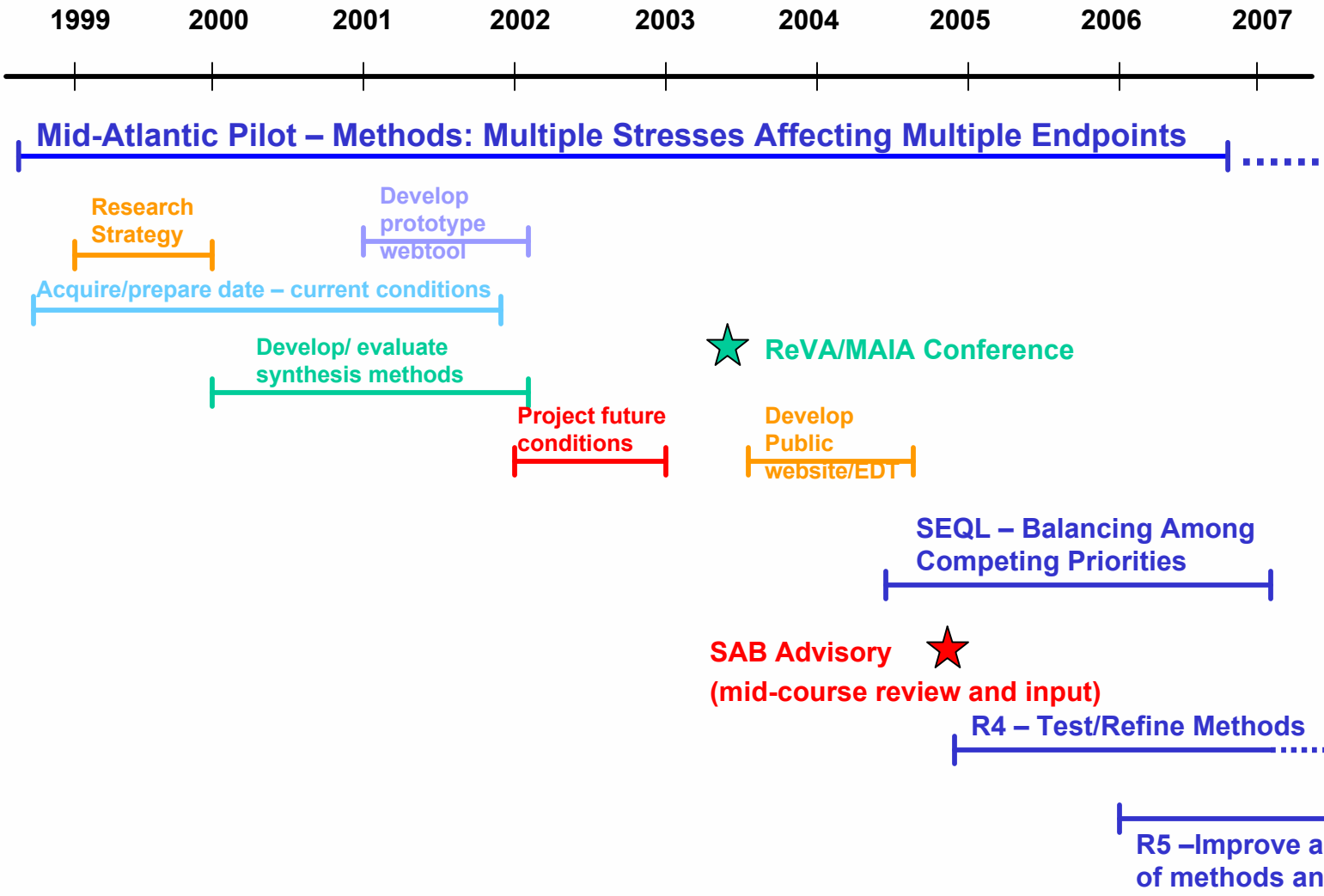
Human activities often place severe strains on the ecological systems of which we are an integral part. The impacts, however, are not uniformly distributed across landscapes and regions (defined here as a multi-state area). Better planning requires that we step back and get an overview of the environmental condition of our regions and how ecological resources are likely to change as a result of society's actions. EPA's Regional Vulnerability Assessment (ReVA) program is designed to produce the methods needed to understand a region's environmental quality and its spatial pattern. The objective is to assist decision makers in making more informed decisions and in estimating the large-scale changes that might result from their actions. This website includes a basic introduction to the environmental vulnerability assessment approach, and an overview of the ReVA tools and their applications.

Explore Toolkit

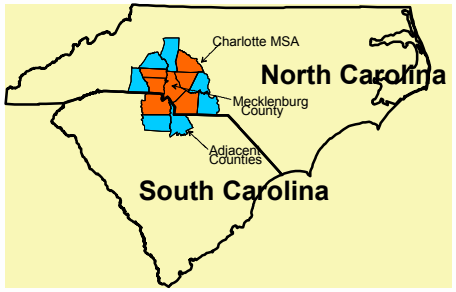
- Environmental Decision Toolkit
- Regional Vulnerability Assessment
- Mid-Atlantic Assessment
- Methods and Data
- What can ReVA do for me?
- Definitions
- References

- If you are interested in assessing regional vulnerability, proceed to Regional Vulnerability Assessment.
- If you are interested in seeing the types of results that a regional vulnerability assessment can produce, proceed to Mid-Atlantic Assessment.
- If you are interested in the technical details of a regional vulnerability assessment, proceed to Methods and Data.
- If you are interested in how a regional vulnerability assessment might help you in your planning and decison-making activitites, proceed to What can a vulnerability assessment do for me?

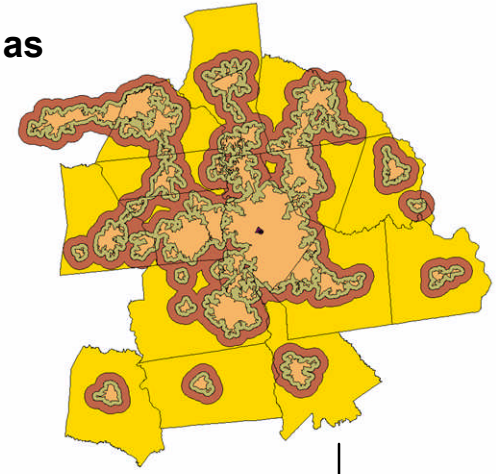
Timeline


1999
2000
2001
2002
2003
2004
2005
2006
2007
Mid-Atlantic Pilot – Methods: Multiple Stresses Affecting Multiple Endpoints
Research Strategy
Develop prototype webtool
Acquire/prepare date – current conditions
Develop/ evaluate synthesis methods
ReVA/MAIA Conference
Project future conditions
Develop Public website/EDT
SEQL – Balancing Among Competing Priorities
SAB Advisory
(mid-course review and input)
R4 – Test/Refine Methods
R5 –Improve accessibility of methods and tools

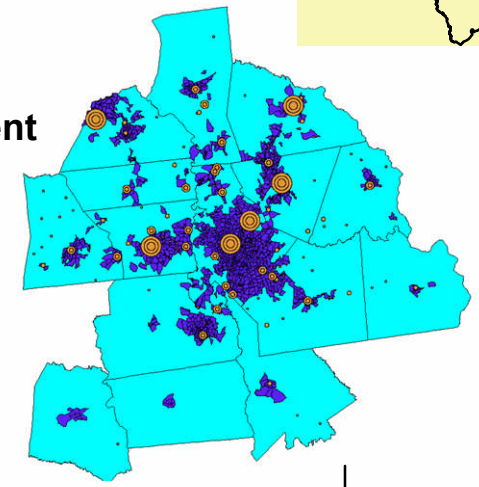
SEQL | SUSTAINABLE ENVIRONMENT for QUALITY of LIFE



Growth as Usual



Centers of Development



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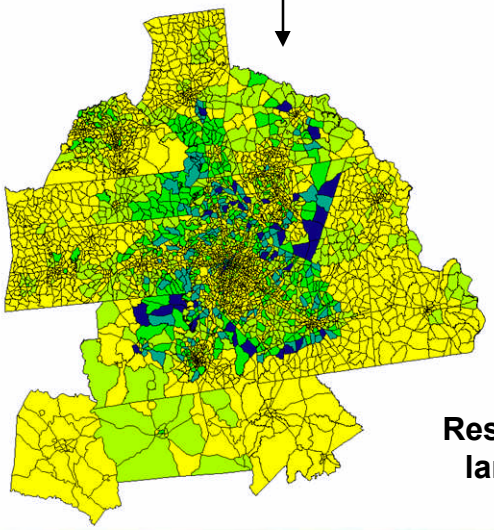
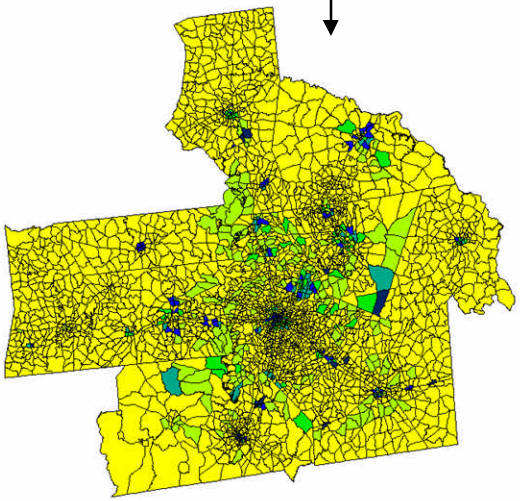




Resulting patterns of land consumption

DEMO ONLY

Air

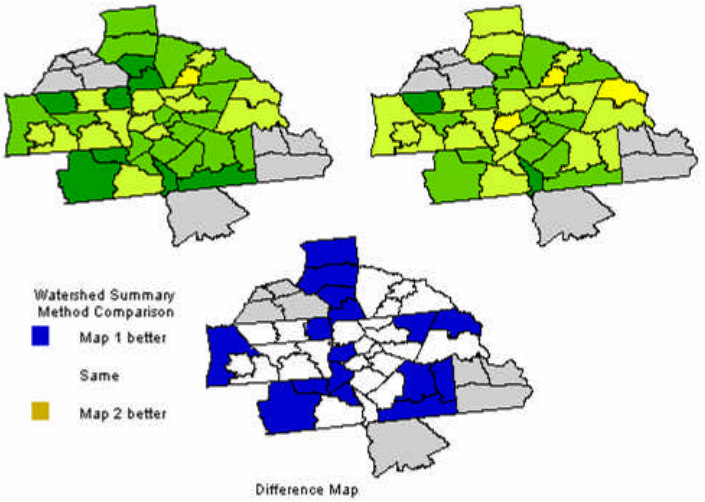
Display Maps Comparing Variables for All of SEQLSubareas

Data for first map: High density
First map groups: Air
First map data: Annual emission of VOC/HH

Data for second map: Low density
Second map groups: Air
Second map data: Annual emission of VOC/HH

Construct Maps

High Density | Low Density



Water

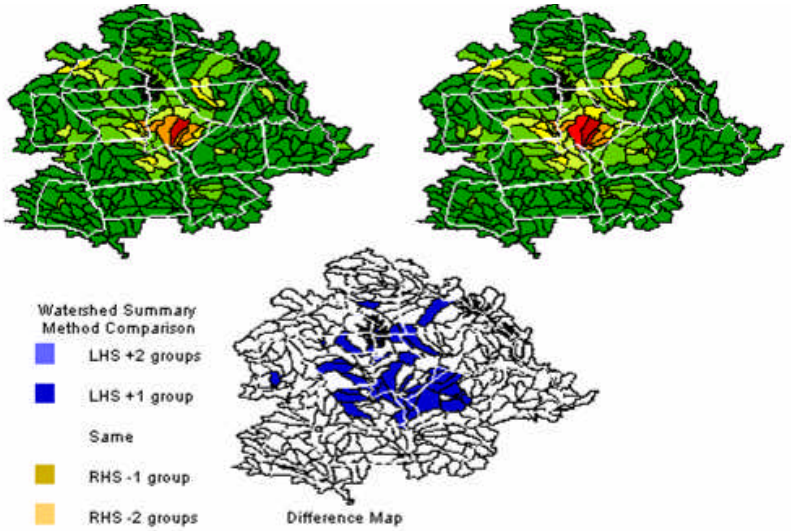
Display Maps Comparing Variables for All of SEQL

Data for first map: High density
First map groups: Terrestrial
First map data: Percent impervious land cover

Data for second map: Low density
Second map groups: Terrestrial
Second map data: Percent impervious land cover

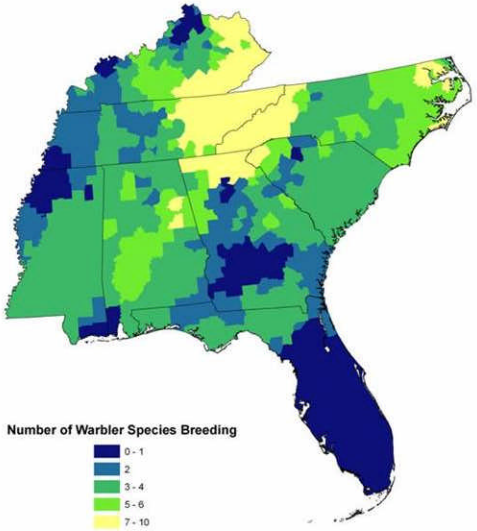
Construct Maps

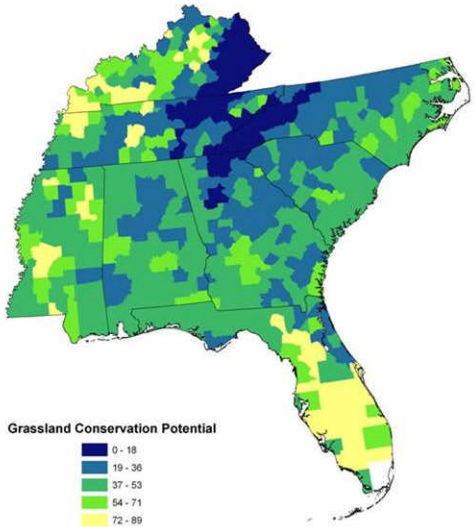
High Density | Low Density

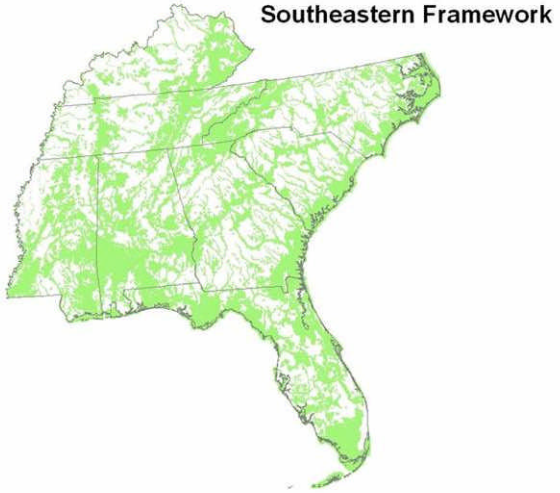


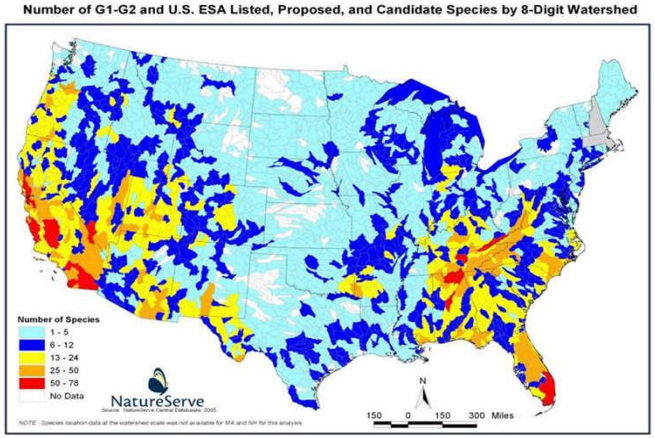
Region 4 Vulnerability Assessment:

Sensitive Ecological Populations





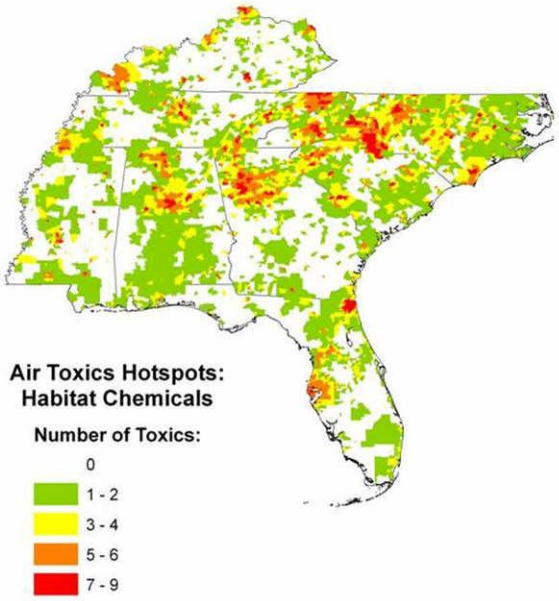


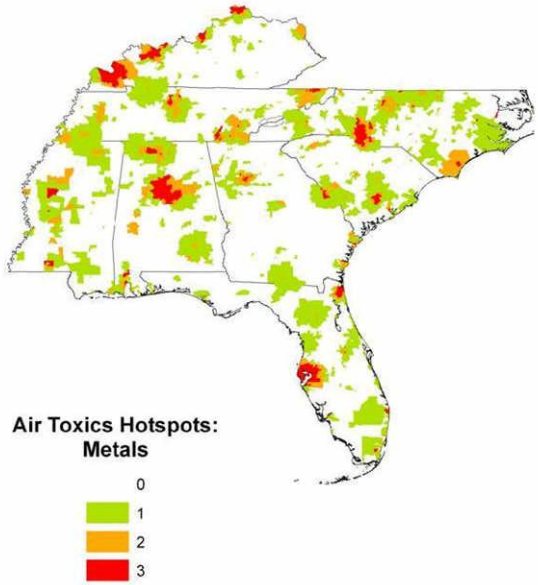


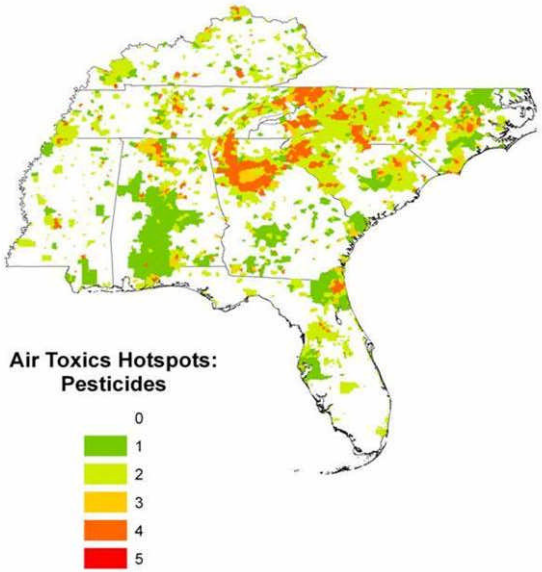
- Habitat for individual species…
- Habitat for guilds of sensitive species….
- Known locations of Threatened and Endangered (T & E) species…
- Potential habitat of T& E species…

Region 4 Vulnerability Assessment:

Hazardous Air Pollutants *(from NATA)*







- Different behaviors in the environment…
- Different toxicity levels for individual species….
- Different exposures across the region….

Region 4 Vulnerability Assessment:
Putting it all together…

$$A_i = \sum_{j}^{n} W_j^p X_{ij}^p + \text{Max}_j W_j X_{ij}$$

W_j = weight of each HAP based on its toxicity and our certainty

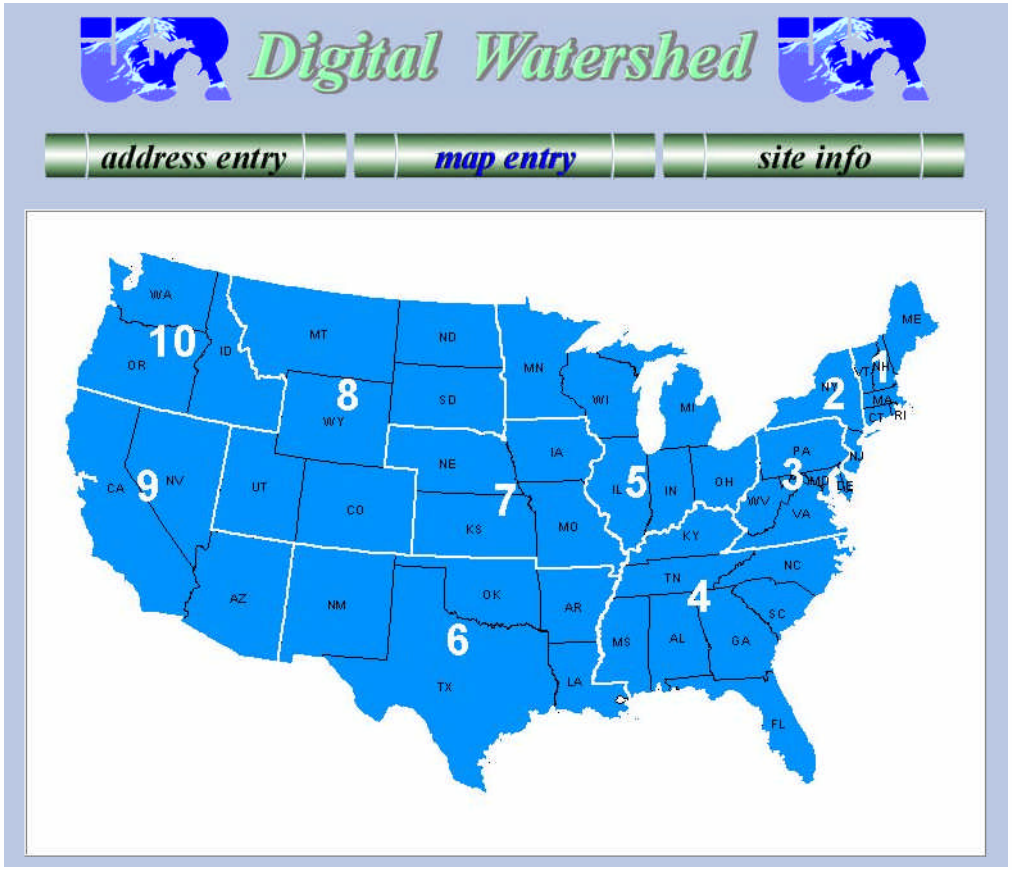
P = weight for locations with unusually high concentrations or overlapping deposition

✦ = a way for us to incorporate information on thresholds, LD 50, statuatory limitations

Integration equation from Tran et al. 2005

Region 5 Work:

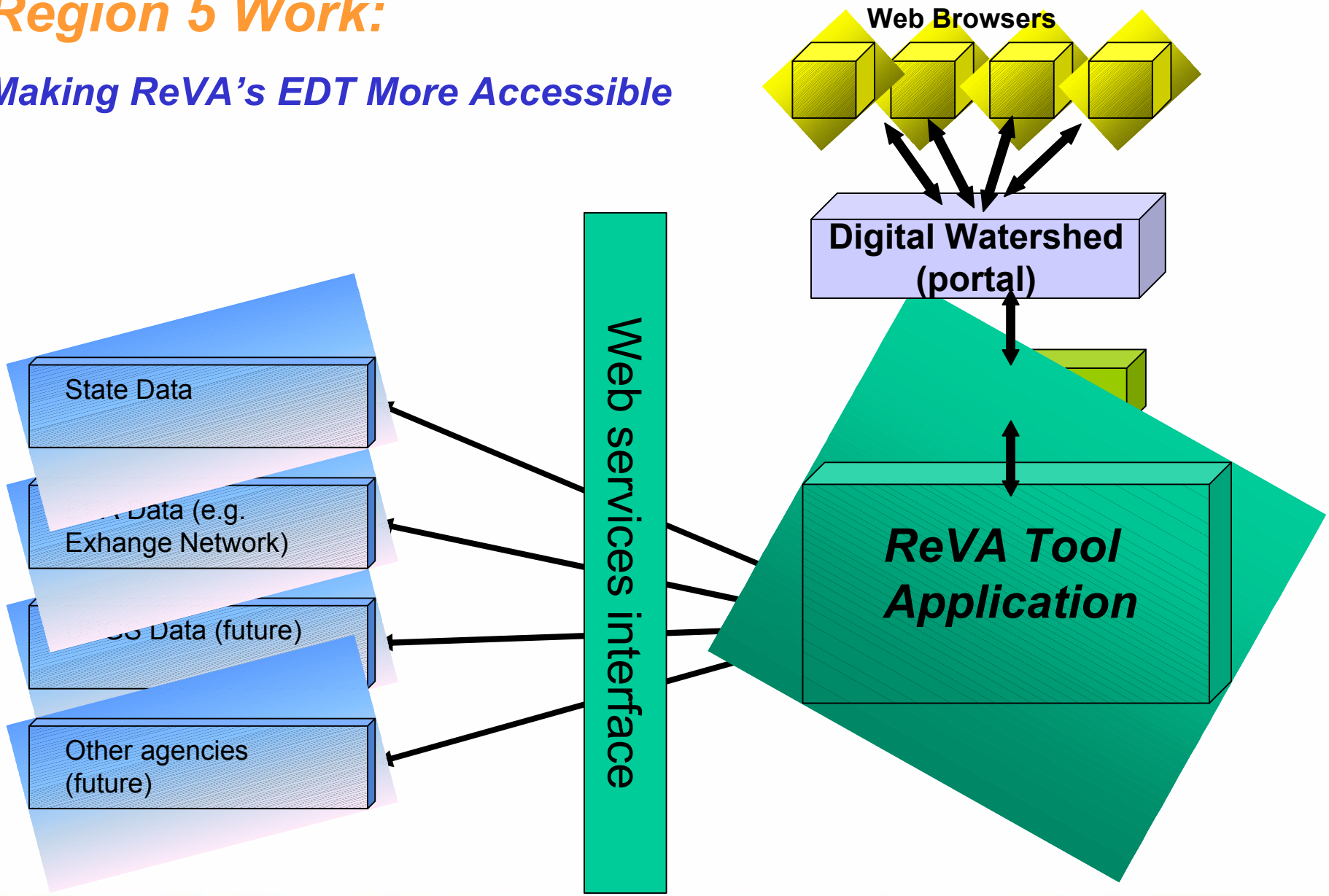
ReVA's regional assessment results available through Digital Watershed



- Nationwide Watershed Coverage
- Multiple Forms of Access
- Comprehensive Datasets
- Scaling Function
- Online Environmental Modeling
- Erosion and Deposition Modeling Online
- Relative Ranking of Watersheds (ReVA EDT) to provide regional context
- Local to Regional Conservation Assessment
- Overall Vulnerability (Sustainability) Assessment

Region 5 Work:

Making ReVA's EDT More Accessible



Types of Questions ReVA Can Address

With Available Data Only:

- What are distributions of individual resources, stressors?
- What are regional conditions, vulnerabilities, sensitivities, relative rankings?
- Creation of topical indices to address management questions, issues, performance tracking.

Types of Questions ReVA Can Address

With Addition of Alternative Scenarios:

- Areas vulnerable to future stresses (e.g. public site)
- Comparison of trade-offs associated with development (e.g. SEQL)
- Estimation of impacts of highway location
- Implications of regional environmental policies
- Impacts of proposed environmental regulations (e.g. work with OAQPS, Region 4)
- Effectiveness of existing regulations (theoretical)

ReVA: the Future

- ReVA Guidelines available FY 07
- OAQPS National Ecosystem Assessment Toolkit Prototype FY07 (phase 1)
- MW-EDT Protoype FY07
- Southeast Vulnerability Assessment, Phase 1 (aggregate toxics), 2008
- Webservices (?)